REMARKS

Claims 1, 10 and 36 have been amended. Claims 34 and 35 have been cancelled. No new matter has been added. Thus, claims 1-33 and 36-42 are pending.

Applicants would like to thank Examiner Uhlir for indicating that claims 39, 41 and 42 contain allowable subject matter.

Rejection under 35 U.S.C. § 112

The rejection of Claims 34-36 has been obviated by appropriate amendment. Claims 34 and 35 have been cancelled without prejudice to their pursuit in a continuation or divisional application. Claim 36 has been amended to be dependent on claim 5.

Rejection under 35 U.S.C. § 103

Rejection over Alivisatos et al.

Claims 1-2, 4-5, 7, 9-13, 15-16, 20-24, 27-29, 31-32 and 40 were rejected under 35 U.S.C. § 103(a) over Alivisatos et al. (U.S. Patent No. 5,537,000). The Office Action asserts that Alivisatos et al. discloses an electron transport layer made of 2-6 semiconductor nanocrystals which can be n-doped when a current/voltage is applied so as to locate the recombination zone in the hole transport layer. The Office Action further asserts that this process adds electrons to the semiconductor nanocrystals.

The rejections of claims 1-2, 4-5, 7, 9-13, 15-16, 20-24, 27-29, 31-32 and 40 over Alivisatos et al. have been obviated by appropriate amendment. As amended, claim 1 now recites that the doped semiconductor nanocrystal comprises a carrier in a quantum confined state, and that the carrier remains in the quantum confined state in the absence of an applied electric potential. As amended, claim 10 now recites that the carrier remains in a quantum confined state in the absence of an applied electric potential. Applicants note that the specification defines "doped" as containing "at least one added carrier, either one or more electrons or one or more holes, <u>in quantum confined states</u>" (p. 2, lines 16-18; emphasis added). In addition to this definition, the quantum confinement of carriers in the doped semiconductor nanocrystals as claimed is

further discussed in the specification, for example from page 7, line 25 through page 8, line 26. Doped semiconductor nanocrystals as claimed can be formed by chemical doping and by photo doping without the use of any applied electric potential (p. 6, lines 17-29; p. 8, line 27 – p. 9, line7). Moreover, doped semiconductor nanocrystals as claimed can be formed by electrochemical doping under an applied potential; however the carriers generated by this doping process remain in quantum confined states after the doping process is complete and there is no longer an applied electric potential (p. 6, line 30 – p. 7, line 10).

In contrast, Alivisatos et al. does not teach or suggest doped semiconductor nanocrystals having carriers in quantum confined states in the absence of an applied electric potential. The semiconductor nanocrystals in the electron transport layer of Alivisatos et al. are not described as containing any dopants, nor are they described as containing a carrier in a quantum confined state. Rather, the Office Action asserts that electrons are present in the nanocrystals when an electric potential is applied in such a manner that the recombination zone is located in the electron transport layer (Paper No. 11, p. 4, paragraph 10). Without the application of the electric potential, there can be no excess electrons in the electron transport layer, and thus no semiconductor nanocrystals containing a carrier in a quantum confined state. Alivisatos et al. does not teach or suggest, nor does the Office Action assert that Alivisatos et al. teaches or suggests, a doped semiconductor nanocrystal comprising a carrier in a quantum confined state, where the carrier remains in a quantum confined state in the absence of an applied electric potential. Accordingly, independent claims 1 and 10 are not obvious over Alivisatos et al., as the reference does not teach or suggest each and every element of the claims. Claims 2, 4-5, 7, 9, 28-29 and 31-32 depend from claim 1, and claims 11-13, 15-16, 20-24, 27 and 40 depend from claim 10, and these claims likewise are not obvious over Alivisatos et al.

In addition to the reasons set forth above, the rejection of claims 11 and 12, and of claims 20, 22-23, 27 and 40 which depend from these claims, over Alivisatos et al. is respectfully traversed. Applicants respectfully point out that the Office Action's interpretation of these claims is not consistent with the claim language in view of Applicants' specification. As noted in MPEP 2111.01:

> ... the words of the claims must be given their plain meaning unless applicant has provided a clear definition in the specification. [Emphasis added]

The overly broad interpretations of the language of claims 11 and 12 set forth by the Office Action are not in keeping with these guidelines and further would result in no discernable difference between these dependent claims and independent claim 10.

With respect to claim 11, the Office Action has asserted that "oxidizing or reducing agent" means "anything that results in oxidation or reduction" (Paper No. 11, p. 6, paragraph 18). This working definition is not consistent with how these terms "would be interpreted by those of ordinary skill in the art" (MPEP 211.01), nor is it consistent with the definitions in the specification. The *McGraw-Hill Encyclopedia Of Science & Technology*, 9th Edition, defines an oxidizing agent as:

> A participant in a chemical reaction that absorbs electrons from another reactant. In the process a component atom of this substance undergoes a decrease in oxidation number. In this action as an oxidizing agent, the substance undergoes reduction.
> [Johnson, F.J. "Oxidizing agent" in *McGraw-Hill Encyclopedia Of Science & Technology*, 9th Edition, New York: McGraw-Hill., 2002, p. 653]

A copy of the reference containing this definition is attached as Appendix A. This standard definition of an oxidizing agent (and, by extension, a reducing agent) is consistent with the disclosure in Applicants' specification, which states that:

> Chemical doping may be carried out by contacting the semiconductor nanocrystal to a reducing agent or an oxidizing agent. [p. 6, lines 17-18; emphasis added]

The specification further provides specific examples of reducing agents (p. 6, lines 20-24) and of oxidizing agents (p. 6, lines 24-26). Thus, it is clear that an oxidizing or reducing agent as recited in claim 11 is a chemical substance that is contacted with the

semiconductor nanocrystal in order to add an electron or a hole to the nanocrystal. There is no support for the Office Action's assertion that an applied electric current or electric potential is an oxidizing or reducing agent as claimed. Accordingly, and in addition to the reasons set forth above, claims 11, 20, 22, 27 and 40 are not obvious over Alivisatos et al., as the reference does not teach or suggest each and every element of the claims.

With respect to claim 12, the Office Action has asserted that "oxidizing or reducing electrochemically" likewise means "anything that results in oxidation or reduction" since "oxidation and reduction are electrochemical reactions" (Paper No. 11, p. 6, paragraph 19; and p. 12, paragraph 45). This working definition is also not consistent with how these terms "would be interpreted by those of ordinary skill in the art", nor with the definitions in the specification. The *McGraw-Hill Encyclopedia Of Science & Technology*, 9th Edition, defines electrochemistry as:

> ... dealing with the chemical changes accompanying the <u>passage of an electric current</u>...
> [Fry, A.J. "Electrochemistry" in *McGraw-Hill Encyclopedia Of Science & Technology*, 9th Edition, New York: McGraw-Hill., 2002, p. 252; emphasis added]

A copy of the reference containing this definition is attached as Appendix B. This standard definition of electrochemistry (and, by extension, a process carried out electrochemically) is consistent with the disclosure in Applicants' specification, which states that:

> Electrochemical doping may be carried out by <u>forming a mixture</u> of a <u>solvent</u> and colloidal semiconductor nanocrystals, together with an <u>electrolyte</u>.
> [p. 6, lines 30-31; emphasis added]

The specification further provides a description of an electrochemical doping process and provides specific examples of solvents and electrolytes (p. 6, line 31 – p. 7, line 10). Thus, it is clear that oxidizing or reducing electrochemically as recited in claim 12 is

carried out in a solvent containing an electrolyte. There is no support for the Office Action's assertion that the application of electric current or electric potential to a solid state device without the presence of a solvent or an electrolyte is equivalent to oxidizing or reducing electrochemically as claimed. Accordingly, and in addition to the reasons set forth above, claims 12 and 23 are not obvious over Alivisatos et al., as the reference does not teach or suggest each and every element of the claims.

Rejection over Kawasaki et al. and White et al.

Claims 1-5, 7, 9-16, 20-24, 27-29, 31-32 and 38 were rejected under 35 U.S.C. § 103(a) over Kawasaki et al. (U.S. Patent No. 6,057,561) in view of White et al. (U.S. Patent No. 6,342,313).[2] The Office Action asserts that Kawasaki et al. discloses ZnO semiconductor nanocrystals, and that these ZnO nanocrystals could be doped p- type or n-type. The Office Action further asserts that White et al. discloses a method of making p-type ZnO and n-type ZnO, and that these methods can be combined with the nanocrystals of Kawasaki et al.

The rejections of claims 1-5, 7, 9-16, 20-24, 27-29, 31-32 and 38 over Kawasaki et al., alone or in combination with White et al., have been obviated by appropriate amendment. As amended, claim 1 now recites that the doped semiconductor nanocrystal comprises a carrier in a quantum confined state at room temperature. As amended, claim 10 now recites that the carrier remains in a quantum confined state at room temperature. The room temperature quantum confinement of the carriers in Applicants' doped semiconductor nanocrystals is shown by the optical measurements as described in the Examples (p. 11, line 5 – p. 15, line 26). All of these measurements were carried out at room temperature, and the particles were also kept at room temperature just prior to and in between measurements (p. 13, lines 17- 22).

In contrast, Kawasaki et al. does not teach or suggest doped semiconductor nanocrystals having carriers in quantum confined states at room temperature. The only evidence of quantum confinement of carriers in Kawasaki et al. comes from

[2] Although paragraph 29 on page 9 of the Office Action lists only claims 1-5, 7, 9-16, 20-22, 27-29, 31-32 and 38 claims 21-24 are discussed within this section in paragraph 50 on page 13 of the Office Action. Accordingly, this response has assumed that the rejection over Kawasaki et al. in view of White et al. is directed to claims 1-5, 7, 9-16, 20-24, 27-29, 31-32 and 38.

photoluminescence spectra obtained at 4.2 K (- 267°C) (col. 13, lines 7-13 and Fig. 30). The semiconductor nanocrystals disclosed in Kawasaki et al. do not appear to be capable of exhibiting quantum confinement at room temperature, even if the nanocrystals could be doped as proposed by the Office Action. White et al. does not teach or suggest, nor does the Office Action assert that White et al. teaches or suggests, doped semiconductor nanocrystals having carriers in quantum confined states. Accordingly, independent claims 1 and 10 are not obvious over Kawasaki et al. or White et al., as the references, alone or in combination, do not teach or suggest each and every element of the claims. Claims 2-5, 7, 9, 28-29 and 31-32 depend from claim 1, and claims 11-16, 20-24, 27 and 38 depend from claim 10, and these claims likewise are not obvious over Kawasaki et al. or White et al.

In addition to the reasons set forth above, the rejection of claims 12 and 23 over Kawasaki et al. in view of White et al. is respectfully traversed. Applicants respectfully point out that the Office Action's interpretation of these claims is not consistent with the claim language in view of Applicants' specification, as noted above with respect to the rejections of these claims over Alivisatos et al. Neither Kawasaki et al. nor White et al. teach or suggest, nor does the Office Action assert that the references teach or suggest, electrochemical doping as recited in the claims. Specifically, the references do not teach or suggest oxidizing or reducing electrochemically in a process carried out in a solvent containing an electrolyte. Accordingly, and in addition to the reasons set forth above, claims 12 and 23 are not obvious over Kawasaki et al., alone or in combination with White et al., as the references do not teach or suggest each and every element of the claims.

Rejection over Alivisatos et al. and Bhargava et al.

Claims 6, 17-18, 25-26 and 33 were rejected under 35 U.S.C. § 103(a) over Alivisatos et al. in view of Bhargava et al. (U.S. Patent No. 6,241,819). These rejections have been obviated by appropriate amendment. As noted above, independent claims 1 and 10 are not obvious over Alivisatos et al., as the reference does not teach or suggest each and every element of the claims. Alivisatos et al. does not teach or suggest a doped semiconductor nanocrystal comprising a carrier in a quantum confined state,

where the carrier remains in a quantum confined state in the absence of an applied electric potential. Likewise, Bhargava et al. does not teach or suggest, nor does the Office Action assert that Bhargava et al. teaches or suggests, a doped semiconductor nanocrystal comprising a carrier in a quantum confined state. Claims 6 and 33 depend from independent claim 1, and claims 17-18 and 25-26 depend from independent claim 10. Accordingly, claims 6, 17-18, 25-26 and 33 are not obvious over Alivisatos et al., alone or in combination with Bhargava et al., as the references do not teach or suggest each and every element of the claims.

In addition to the reasons set forth above, the rejection of claims 6, 17-18 and 25-26 over Alivisatos et al. in view of Bhargava et al. is respectfully traversed. Applicants respectfully point out that the Office Action's interpretation of these claims, which recite a colloid comprising the claimed particles or a method of making such a colloid, is not consistent with the claim language in view of Applicants' specification. Specifically, the term "colloid" is described in the specification as including semiconductor nanocrystals dispersed in a liquid solvent (p. 4, lines 16-22). A colloid of semiconductor nanocrystals can be formed into a film by applying the colloid to a surface and evaporating the solvent from the colloid (p. 5, lines 25-27; p. 7, lines 11-18). Thus, the mixture of semiconductor nanoparticles in a poly(ethylene oxide) matrix as disclosed in Bhargava et al. is not equivalent to a dispersion of semiconductor nanocrystals in a liquid solvent. Accordingly, and in addition to the reasons set forth above, claims 6, 17-18 and 25-26 are not obvious over Alivisatos et al., alone or in combination with Bhargava et al., as the references do not teach or suggest each and every element of the claims.

Rejection over Alivisatos et al., Bawendi et al. and "Bawendi ACS"

Claims 8, 19 and 37 were rejected under 35 U.S.C. § 103(a) over Alivisatos et al. in view of Bawendi et al. (U.S. Patent No. 6,207,229) and "Bawendi ACS" (*J. Am. Chem. Soc.*, 115(19), **1993**, pp. 8706-8715). These rejections have been obviated by appropriate amendment. As noted above, independent claims 1 and 10 are not obvious over Alivisatos et al., as the reference does not teach or suggest each and every element of the claims. Alivisatos et al. does not teach or suggest a doped

semiconductor nanocrystal comprising a carrier in a quantum confined state, where the carrier remains in a quantum confined state in the absence of an electric potential. Likewise, neither Bawendi et al. nor "Bawendi ACS" teach or suggest, nor does the Office Action assert that Bawendi et al. or "Bawendi ACS" teach or suggest, a doped semiconductor nanocrystal comprising a carrier in a quantum confined state. Claims 8 and 37 depend from independent claim 1, and claim 19 depends from independent claim 10. Accordingly, claims 8, 19 and 37 are not obvious over Alivisatos et al., alone or in combination with Bawendi et al. or "Bawendi ACS", as the references do not teach or suggest each and every element of the claims.

Rejection over Kawasaki et al. and "Bhargava 286"

Claim 30 was rejected under 35 U.S.C. § 103(a) over Kawasaki et al. in view of "Bhargava 286" (U.S. Patent No. 5,446,286). This rejection has been obviated by appropriate amendment. As noted above, independent claim 1 is not obvious over Kawasaki et al., as the reference does not teach or suggest each and every element of the claims. Kawasaki et al. does not teach or suggest doped semiconductor nanocrystals having carriers in quantum confined states at room temperature. Likewise, "Bhargava 286" does not teach or suggest, nor does the Office Action assert that "Bhargava 286" teaches or suggests, doped semiconductor nanocrystals having carriers in quantum confined states. Claims 30 ultimately depends from independent claim 1. Accordingly, claim 30 is not obvious over "Bhargava 286", as the reference does not teach or suggest each and every element of the claims.

Conclusion

In conclusion, all of the grounds raised in the outstanding Office Action for rejecting the application are believed to be overcome or rendered moot based on the remarks above. Thus, it is respectfully submitted that all of the presently presented claims are in form for allowance. Should the Examiner feel a discussion would expedite the prosecution of this application, the Examiner is kindly invited to contact the undersigned.

Respectfully submitted,

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